# Contoh Kasus Bangunan dengan Pendekatan Sustainability

Disunting dari Holcim Award

Oleh

Sugini

# Five target issues for sustainable construction

Quantum change and transferability

Ethical standards and social equity

Ecological quality and energy conservation

Economic performance and compatibility

Contextual and aesthetic impact

# Office building in Costa Rica

# Quantum change and transferability

Shading is a simple and direct way to keep indoor climates cooler, and it can be applied anywhere. The Holcim Costa Rica office building has at least seven types of shading systems that reduce thermal gain through the roof and facades.

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# Quantum change and transferability

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In hot climates, preventing thermal gain makes much more sense than allowing it and then counteracting it with expensive, energy-intensive mechanical air-conditioning systems.

# Ethical standards and social equity

A bright, well designed building is a pleasure to work in every day. And a true piece of architecture is an inspiration.

Especially in poor countries, sustainable construction means building to supply urgent and basic needs: shelter, water, schools, access to goods and services, and medical care. In other countries, affordable housing is a main issue. In still others, the problem is wasteful and excessive consumption, which might be financially affordable but is irresponsible. Leaving sufficient materials and resources for others, including future generations, is a moral duty.

Sustainable construction means cities and buildings that respond to the emotional and psychological needs of people by providing stimulating environments, raising awareness of important values, inspiring the human spirit, and bonding societies, communities, and neighborhoods. Many sustainable construction projects are developed by teams using a collective approach through which stakeholders and users are included in the design process. Sustainable construction involves the highly-principled treatment of people during the design, construction, use, and recycling of buildings.


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The employees knew they were getting a special office building, but still they were surprised to see how the sensitive design began to change the way they acted and thought.

# Ecological quality and energy conservation

Modern architecture can blend magnifi-cently with nature. If we are to build sustainably, it must



A fundamental principle of sustainable development is to keep our planet in condition to indefinitely support future generations. This is an enormous challenge because our global ecosystem is in a state of stress and overuse. Finite sources of energy and materials are being depleted, and much of our environment is being polluted or spoiled.

The construction industry plays a great role here as a large consumer of materials and energy. At the building scale, sustainable construction aims to provide longlasting, healthful, and useful buildings while conserving finite resources of materials and energy by using durable, recyclable, and renewable materials, through energy-efficient design, and by using environmentally neutral energy sources (wind, sun, geothermal, etc.) and mechanisms (shading, simple evaporation cooling, etc.).

The building design takes advantage of many renewable resources and assets available on the site including sunlight, shade, vegetation, sea breeze, and water.

The use of durable weather-resistant materials keeps main-tenance costs low.

High-quality modern building materials such as metal, glass, and concrete are energy-intensive to produce but highly durable, making ecological sense in the long term.

# Economic performance and compatibility

The investment in shading will pay off every day throughout the life of the building by greatly reducing the cost of air conditio-ning.

# Contextual and aesthetic impact

The building is a pleasure for the eye from many angles.

# Technical report

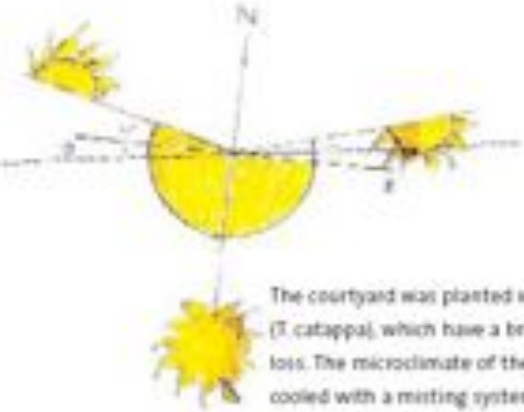
# site

| | |
|---|---|
| Location | San Antonio de Belén, San José, Costa Rica |
| Climate | Tropical |
| Terrain | Flat hilltop |
| Site size | 24,384 $m^2$ (192m x 127m) |
| Setting | Suburban industrial park |
| Number of parking spaces | 117 |

and shading layers was designed. Tensile structures shade the roof and the facades. Massive concrete walls insulate the east and west facades of the two wings. Without further scientific support, but based on the empirical knowledge of the geography and local climate, the drawings were finished and construction carried out. Once the building was completed and occupied, it was necessary to reduce glare in certain rooms. This was done by tinting the glass. In some densely occupied rooms ceiling fans were installed to improve comfort. The central courtyard was landscaped using boulders that were left from the construction of the client's nearby industrial plant.

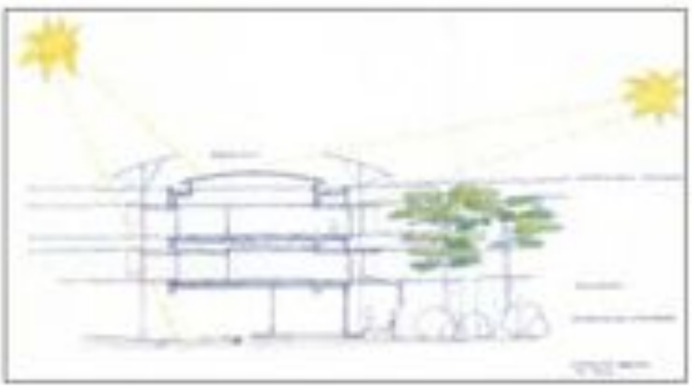

The Holcim Costa Rica office building is approached from the east, across a plaza with an array of climatic fountains and channels. The building comprises four wings surrounding the *jardín de climatización*.

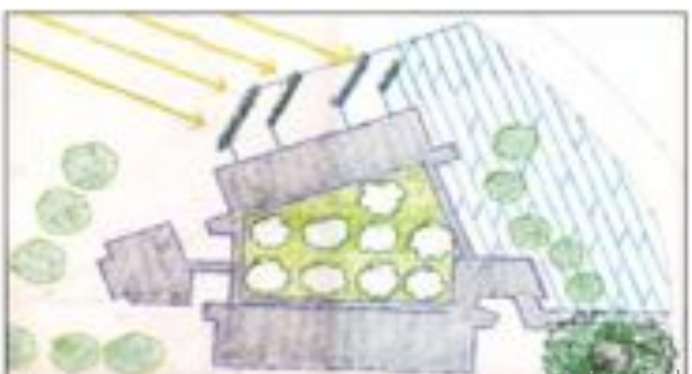
- A North wing
- B Entrance wing
- C South wing
- D Administration wing
- E *Jardín de climatización*
- F Fountains and channels



The courtyard was planted with grass, ivy, and beach almond trees (T. catappa), which have a broad canopy, providing shade to reduce moisture loss. The microclimate of the courtyard can be further humidified and cooled with a misting system, which is activated every ten minutes for ten seconds, from 6 am to 6 pm on working days during the dry season. Plants are watered every morning and evening.

Response to the environment – especially solar radiation in the tropical climate of Costa Rica – was a prime consideration during the desing phase





# Building statistics

| | |
|---|---|
| Year of construction | 2004 |
| Building type | Office |
| Building volume | 15,214 m³ in four wings |
| Maximum number of occupants | 162 |
| Gross usable floor area | 3,896 m² |
| Number of finished floors | 2 |
| Number of basements | – |
| Construction system | Reinforced concrete slabs, walls and post-and-beam frame, extensive shading systems for roof and facades |
| Construction cost (building only) | USD 2,564,800 or USD 658/m² gross floor area |
| Construction cost of typical office buildings in Costa Rica | USD 580/m² gross floor area* |
| Annual operating cost (cooling, lighting, mech. systems, etc.) | USD 9.24/m² |
| Annual operating cost of typical office buildings in Costa Rica | USD 27.60/m²* |

* Source: [illegible] Company of Power and Electricity (CNFL)

# Measuring illuminance, temperature, humidity, and air speed

Illuminance was measured in lumens per m² using a Hobos system (model H08-004-02) set up in the southern wing. One sensor monitored average light conditions in the building and a second sensor was directed toward the north-facing windows to read during the late afternoon and sunset hours, times when illuminance could become excessive.

Air temperature and relative humidity were monitored at six locations in the building using the same Hobos system. In the north wing, sensors were positioned in the middle of the room and inside an office. In the south wing, two sensors were placed in the middle of the hall and one in the stairway between the ground floor and upper floor. Another sensor was positioned in a shaded corridor on the southern side of the courtyard. All sensors were programmed to record average values at ten-minute intervals during 24-hour cycles. Readings taken in the stairway were not used in calculations of average values for the building.

Air movement inside the building and wind speed outside the building were measured during times of maximum winds (October 2004 and February 2005). Two pairs of anemometers (MetOne, model 014A) were set up, one on the upper floor of the administration wing (west wing), and the other on the ground floor at the east end of the building. In each case, one anemometer was positioned inside and the other outside the building. The data was recorded by a data logger (Campbell Scientific model CR10X) programmed to record average and maximum wind speeds at ten-minute intervals during 24-hour cycles.

Several shading devices protect the north wing against the low late-afternoon sun, including three metal trellises (right) that will soon be covered with vines.

Shading and ventilation instead of mechanical air conditioning provide a comfortable indoor climate. Three shading mechanisms are visible here: a fabric canopy, vertical sun blocks, and horizontal louvers.

# Optimizing the indoor climate

Illuminance inside the building was measured to be within the comfort range, typically below 1,500 lumens per m² (Figures 1A, 2A). In offices and halls with north- or south-facing windows illuminance was found to be excessive all day, and especially during early morning and late afternoon. To correct this problem additional louvers and screens were installed. Temperatures measured at five locations in the building show the diurnal pattern typical of tropical climates, with strong diurnal fluctuations (10°C or more), but stable average conditions throughout the year (Figures 1B, 2B). *Minimum daily temperatures* were typically observed at pre-dawn hours (5 am to 6 am), and varied from 18°C to 20°C during both rainy and dry seasons. *Maximum daily temperatures* were observed during the early afternoon (12 noon to 2 pm) and varied from 26°C to 28°C during both seasons. *Average temperatures* during working hours (8 am to 7 pm) were near 24°C to 25°C during both seasons. Compared with mean and maximum temperatures observed outdoors (22°C and 28.5°C, respectively), the building provided a comfortable climate, with indoor temperatures close to the average recorded outdoors, but with far lower maximum temperatures. The stairway between the ground floor and upper floor is an exceptional situation. This volume is wrapped in glass, which creates a greenhouse effect throughout the day. Temperatures here reached almost 32°C, uncomfortably hot. The temperature here is expected to drop substantially once the shading plants and trees grow. *Mean and maximum air temperatures predicted* using the Comfort model were 24.9°C and 24.4°C during the dry season and 26.6°C and 25.9°C during the rainy season, respectively. In comparison with actual values measured in the building, the model underestimated maximum air temperature during the rainy season (see table page 47).

Figure 1: Diurnal patterns (in days) of illuminance, air temperature and relative humidity inside the Holcim building during rainy and dry seasons

- Illuminance (lum m⁻²) x 10²
- Temperature (°C)
- Humidity (%)
- Days

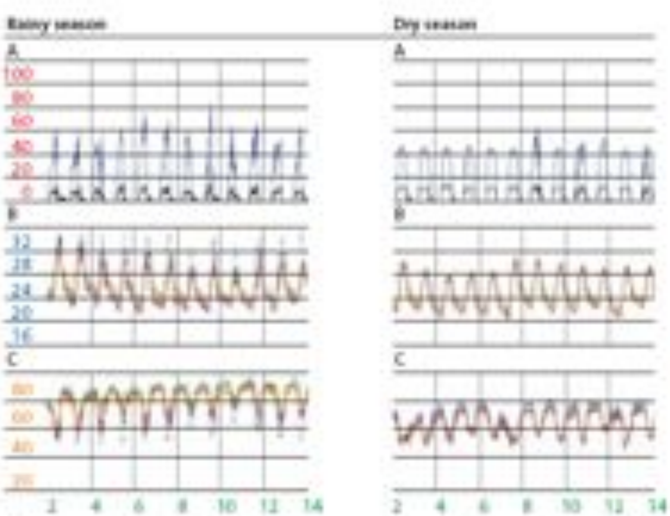
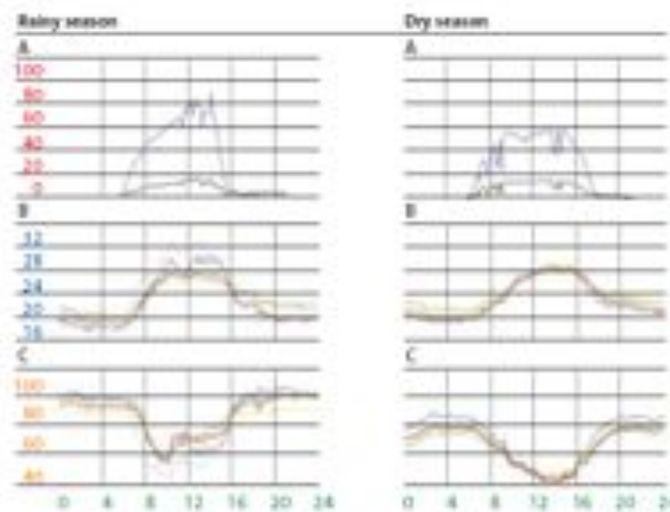



Figure 2: Diurnal patterns (in hours) of illuminance, air temperature and relative humidity inside the Holcim building during rainy and dry seasons

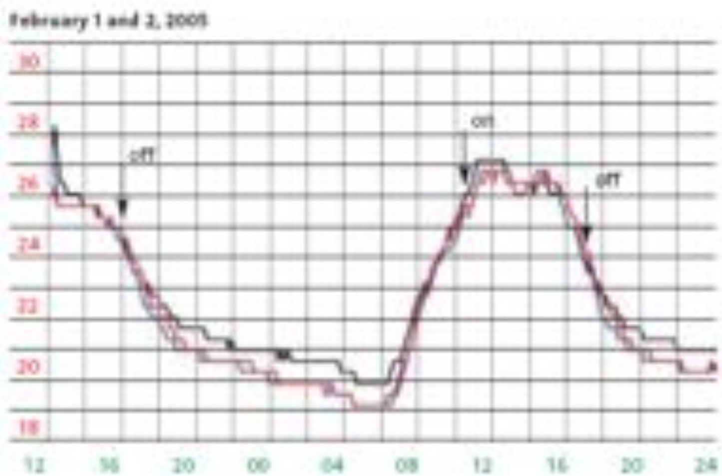
- Illuminance (lum m⁻²) x 10²
- Temperature (°C)
- Humidity (%)
- Days



Excessive air movement caused several problems. Papers were blown about and dust was spread, particularly during the early dry season. The excessive air movement made cooler weather chillier and made hot dry weather worse by contributing to dehydration and overheating. Air movement was an asset during hot and humid weather because natural ventilation speeds evaporation, thereby improving comfort. Ceiling fans were installed in some rooms (Figure 4).

Figure 4:
How fan operation during working hours affects air temperature inside the building during the dry season

- Temperature (°C)
- Time of day
- office with fan
- office courtyard
- office without fan




Measured by ISO comfort standards, the Holcim Costa Rica office building provides a comfortable indoor climate during working hours (see table below). The indoor climate is comfortable but slightly hot during the dry season, and comfortable but slightly humid during the rainy season.

| Environmental variable | Dry season | Rainy season |
|---|---|---|
| Mean temperature (°C) (actual conditions, indoors) | 24.19 ± 0.11 | 24.80 ± 0.28 |
| Mean temperature (°C) ('Comfort' model, indoors) | 24.90 | 24.40 |
| Relative humidity (%) (actual conditions, indoors) | 53.07 ± 1.13 | 72.90 ± 1.45 |
| Maximum temperature (°C) (actual conditions, indoors) | 26.04 ± 0.33 | 27.47 ± 0.87 |
| Maximum temperature ('Comfort' model) | 26.60 | 25.90 |
| Comfort conditions (ISO norms) | Comfortable, slightly hot | Comfortable, slightly humid |

Indoor environmental and comfort conditions in the Holcim Costa Rica office building during the dry and rainy seasons.

Even in a highly seasonal tropical climate, a comfortable indoor climate can be achieved in buildings with ecological and economical passive cooling and humidification systems instead of expensive and energy-intensive

The misting-cooling system in the courtyard is activated for ten seconds every ten minutes during the dry season. The courtyard air flows into the building, providing humidity and cooling.